



Research Department Report

A REVIEW OF THE AIRBORNE SOUND INSULATION REQUIREMENTS FOR BROADCASTING STUDIOS AND ANCILLARY AREAS

R. Walker, B.Sc.(Eng.), C. Eng., M.I.E.E.

A REVIEW OF THE AIRBORNE SOUND INSULATION REQUIREMENTS FOR BROADCASTING STUDIOS AND ANCILLARY AREAS

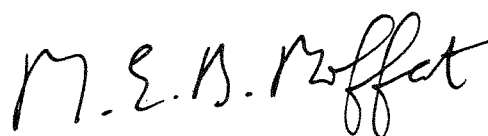
R. Walker, B.Sc.(Eng)., C.Eng., M.I.E.E.

Summary

Experience over the past nine years with the airborne sound insulation criteria has shown that they are stringent. In new developments their application is limited by financial constraints and additionally in refurbishments by structural constraints. Discussions during the past years have taken place on attempts and methods to reduce the requirements. This review began as a study of existing criteria in order to define more closely some of the categories and thus, perhaps, reduce some of the apparent requirements. It has been found that the original bases of the majority of the sound insulation criteria are still appropriate, but that a small number of categories can be adjusted. The opportunity has been taken to incorporate some new data and to allow for changes in background noise level criteria for some area categories. A study of a possible relaxation of the criteria for the special case of a studio to its own control area was abandoned when it became clear that the same relaxations could be applied to all areas.

Index terms: *Insulation; acoustics; noise; studios; standards*

Issued under the Authority of



**Research Department, Engineering Division,
BRITISH BROADCASTING CORPORATION**

Head of Research Department

A REVIEW OF THE AIRBORNE SOUND INSULATION REQUIREMENTS FOR BROADCASTING STUDIOS AND ANCILLARY AREAS

R. Walker, B.Sc.(Eng)., C.Eng., M.I.E.E.

1.	Introduction	1
2.	Experience with PH221 and the Changes Required	1
	2.1 Deliberate omissions	1
	2.2 New areas	1
	2.3 Review of existing criteria	2
	2.4 Modifications to background noise criteria	3
	2.5 Revisions of data	3
	2.6 Other changes	4
	2.7 Confirmation of noise sources	4
3.	Details of Changes	4
	3.1 'Own Control Room/Cubicle' criteria	4
	3.2 Television machine rooms	4
	3.3 Television editing areas	4
	3.4 Private offices with monitoring facilities	5
	3.5 Listening Rooms	5
4.	Calculation of the Sound Insulation Criteria	5
	4.1 Main chart	5
5.	Detail Criteria	6
	5.1 Main chart	6
	5.2 Subsidiary chart	6
	5.3 Use of the chart	6
6.	Tolerances	6
	6.1 General	6
	6.2 Programme areas	9
	6.3 Non-programme areas	9
7.	Conclusions	9
8.	References	9
	Appendix 1: Database	11
	Appendix 2: Derivation of 'Own Cubicle' Criteria	12
	A2.1 Background information	12
	A2.2 Delayed monitoring	12
	A2.3 Undelayed monitoring	14
	A2.4 Howlround	15
	A2.5 Summary	15
	A2.6 Calculation of the 'Own Control Room/Cubicle' sound insulation criteria	16
	A2.7 Detail criteria for 'Own Control Room/Cubicle'	16
	A2.8 Outcome	17

© BBC 2004. All rights reserved. Except as provided below, no part of this document may be reproduced in any material form (including photocopying or storing it in any medium by electronic means) without the prior written permission of BBC Research & Development except in accordance with the provisions of the (UK) Copyright, Designs and Patents Act 1988.

The BBC grants permission to individuals and organisations to make copies of the entire document (including this copyright notice) for their own internal use. No copies of this document may be published, distributed or made available to third parties whether by paper, electronic or other means without the BBC's prior written permission. Where necessary, third parties should be directed to the relevant page on BBC's website at <http://www.bbc.co.uk/rd/pubs/> for a copy of this document.

A REVIEW OF THE AIRBORNE SOUND INSULATION REQUIREMENTS FOR BROADCASTING STUDIOS AND ANCILLARY AREAS

R. Walker, B.Sc.(Eng)., C.Eng., M.I.E.E.

1. INTRODUCTION

In any organisation which needs or wishes to control the acoustic interference between areas it is essential to have appropriate criteria in order to set the design targets; this is of paramount importance in a broadcasting or recording studio environment. In all types of organisation, the acoustic separation between areas must be adequate to reduce the interference to an acceptable level. Studio environments differ only in the stringency of the criteria and the more severe difficulties which may result from failure to meet them. For economic reasons, because the additional costs can be very large indeed, it is important that the criteria are not excessively stringent.

The BBC has for many years set criteria for sound insulation between many different types of area. These were first formalised in Ref. 1 and subsequently extensively revised in Ref. 2 (commonly referred to by its internal BBC number, PH221). The experience of nine years of operation with the criteria of PH221 has given justification for some consolidation.

One of the reasons for these changes is that tabular presentation of the criteria given in PH221 omitted some types of areas which subsequently became fairly common. Although the text of that report contained an explanation of principles and method of calculating the required sound insulation, the tables given did not cover every possible combination of area types (because that would be an unreasonably large number). By application of the method and principles, the criteria could be extended to those areas which had been omitted. Unfortunately, the text of such documents is not always read and there have been expectations that the chart alone should cover all possibilities. It is, therefore, desirable that the categories used more nearly represent current practice.

There were also some specific and deliberate omissions from the chart which, on reflection, should perhaps have been included and some oversights and also some changes in operational methods over the period of nine years since the criteria of PH221 were finalised. Over the same period of time, new data has become available for the sound pressure levels in areas about which assumptions were made in the preparation of PH221, up to January 1981. Some of the background noise criteria which are fundamental to the calculation of sound insulation criteria have also been revised in the intervening period.

Altogether, these changes are sufficiently numerous to justify a formal review of the criteria.

2. EXPERIENCE WITH PH221 AND THE CHANGES REQUIRED

2.1 Deliberate omissions

The category 'Own Control Cubicle' has been included in the earlier criterion chart¹ to cover the possibly less-critical situation of the sound insulation between a studio and its own control room (cubicle). It was omitted from PH221 on the grounds that all radio and television areas should be capable of independent working in the studio and the control room. Some experiences with the specification of new studio centres had suggested that, in some cases, these idealistic criteria are too stringent and, if adopted, lead to constructions which are expensive in both space and money. As a result, it was thought that it might be necessary to reinstate the category 'Own Control Room (Cubicle)'.

Another category which was also deliberately omitted from the chart in PH221 was for television machine rooms, that is those rooms containing video-tape and teleciné machines for recording or replaying material but where there is hardly any more requirement for audio quality monitoring than to check whether the sound is present or absent. These 'rooms' typically have little if any sound insulation and sometimes are not even distinct rooms. Even when they are, they often have folding-type partitions which are left open. Their criteria were omitted because, acoustically, they are of little significance. However, despite verbal and written recommendations about these types of areas, it has been quite impossible to avoid the misconception that there had to be a suitable entry somewhere on the insulation criterion chart. This has led to a significant degree of misunderstanding on some projects and the only solution appears to be to extend the chart to include these areas. This leaves open the question of how many more similar types of areas should be specified individually, simply to avoid misunderstandings.

2.2 New areas

Also in television, it is now more common than it was when the data used in PH221 was compiled (1972)² to have dedicated sound editing

areas, for example, Sypher* Suites. The design of these areas has been hindered by the lack of accurate sound insulation requirement data. Reference to other, possibly similar, areas such as dubbing theatres or control rooms has been used to try to resolve the difficulty but this has not been satisfactory. Therefore, a category for TV sound editing areas has been introduced.

2.3 Review of exiting criteria

Opportunity has been taken in this review of the sound insulation criteria to reconsider some of the existing criteria, having had by now about nine years of experience in their application. The main overall conclusion so far is that the criteria are stringent and that they can only be applied realistically to new constructions; even then some restrictions are imposed on their application by financial and space considerations. The original report forecast that this would be the case and states in several places that the criteria are very demanding. However, to quote PH221, *"The sound insulation requirements derived in this work, given as factors the source sound pressure levels, the receiving area background noise criteria and that the interference should be audible for less than 1% of the time, are absolute and unavoidable"*.

In the search for methods of reducing the insulation requirements, the only possible degrees of freedom are those three factors. Discussions continue to take place on the relaxation of background noise criteria and the consequential reduction of the sound insulation requirements for some areas. There is, naturally, a degree of resistance from the users of such areas to such increases in ventilation noise levels above what is otherwise achievable and desirable. Conversely, it is also difficult for a producer trying to get a programme finished or the actors or presenters interested only in the artistic outcome to accept higher probabilities of significant interference. Re-takes are expensive and if an area becomes recognised as 'difficult' it tends to generate a disproportionate number of complaints. However, it is (and always has been) this author's opinion that designing to the peak level of the potentially interfering sound is unduly stringent and that a higher probability of interference would be acceptable. PH221 actually suggested that shortfalls may sometimes be acceptable — *"... a shortfall of 3.5 dB might be tolerated in some circumstances ..."*. This is equivalent to about 1% interference probability. However, the definition of the practical implications of these probabilities is not obvious. The peak level (and, hence close-to-zero interference probability) is at least clear and

unambiguous. The third degree of freedom, that of reducing sound pressure levels in potential sources of interference, is said to be operationally unacceptable but may be the *de facto* control currently in force in many areas. If the standards for sound insulation set out in PH221 are not complied with for any reason then one of the above three factors must be operative.

Because of the very high costs involved, the subject of reductions in the sound insulation criteria has been discussed at great length. One of the principal factors is the statistical relationship between sound levels and their frequency of occurrence. Studies of these relationships have been carried out in the past^{3,4} for studio areas. It is fortunate that the statistical distributions of sound levels for different types of programme area are very similar³ and, with negligible error for these present purposes, can be represented by the one single distribution function shown in Fig. 1. It shows, for all types of programme material, the average relationship between sound levels and the percentage of time for which they occur. The ordinate origin is the datum for the sound insulation criteria as given in Ref. 2 — the 'peak' value of the sound level (the broken-line sections show regions of extrapolation from measured data).

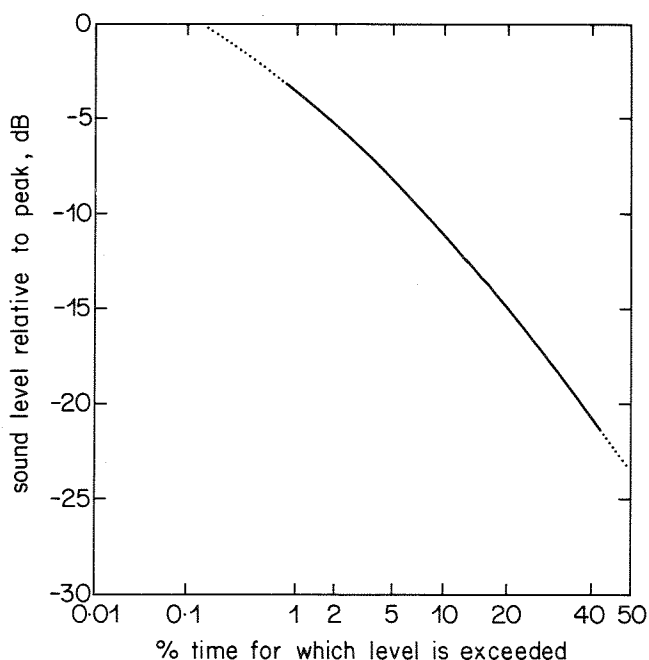


Fig. 1 - Average probability distribution of programme sound levels.

At one stage it was thought that the requirement for sound insulation between a studio and its own, adjoining control area might be less demanding and a worthwhile candidate for potential savings (since it accounts for perhaps more than half of the actual sound insulation cases which have to be

* Sypher (Synchronous post-dub helical scan recording) is an acronym for an editing suite used for adding multi-track sound to video tape recordings.

specified). As a beginning, Radio Capital Projects (RCP) carried out* an extensive survey of the sound insulations between small Radio studios, used for speech only, and their control areas. The objective values were compared both with the criterion and with the users' comments. The outcome was the discovery of a reasonably definite critical threshold of acceptability at a level of about 5 dB below the current criterion. It should be noted that this was a threshold of acceptability not of inaudibility. Thus it was concluded that, for this special case, a routine shortfall in the sound insulation of 5 dB would generally result in areas which could be used for their intended purposes without generating a serious volume of complaints, invoking significant additional revenue expenditure by requiring too many 're-takes' or producing unusable programme.

The survey by RCP was objectively based, in the sense that the usability of each individual case was considered in relation to its measured sound insulation. The derivation of a relaxed 'own-cubicle' criterion was also the prime objective of this review of the sound insulation criteria. However, when the same considerations were applied to all of the other sound insulation cases, necessarily less formally because of the very large number of areas involved, it was seen that the same arguments were applicable. The outcome was the acceptance that, for most areas and for most of the time, a uniform shortfall of about 5 dB from an ideal sound insulation criterion would be operationally tolerable. It must be noted that this will result in audible interference for about 2% of the time and, in terms of the masking effect of background noise⁵, a change from the 'just perceptible' to the 'just disturbing' thresholds (all but 1 dB).

Some other factors have also been considered over the last nine years. Experience has shown that some area categories are not well-represented by PH221. Those of 'Echo Room' and 'Reverberation Plate Room' are obsolescent. Although some such areas still exist, the availability of satisfactory electronic methods means that no new areas of these types are likely to be constructed. The categories have therefore been deleted.

A category included in the PH221 chart was for 'Private offices with Monitoring Facilities'. This used data gathered from offices which had music reproduction facilities used primarily to audition 'pop' records. Experience has shown that this data is too extreme for general design purposes and that a less stringent criterion would be adequate for most purposes. This of course does not mean that the higher levels of sound insulation will no longer be required,

just that those particular requirements will no longer appear in the criterion chart.

2.4 Modifications to background noise criteria

The background noise criteria used in the calculation of sound insulation requirements are mostly as they were for PH221. However, the background noise criteria which apply to most ancillary areas have been revised. It is now required that 'public' areas, such as general offices, canteens, kitchens, etc., conform to ISO NR 45⁶. This has also been taken to include technical areas, such as apparatus rooms and television machine rooms, in which non-critical sound monitoring takes place. Other non-programme and uncritical areas, such as private offices and television lighting and vision control rooms are required to meet ISO NR 35.

2.5 Revisions of data

Some of the area categories included in PH221 had assumptions made about the sound pressure levels which occur within them. The categories of 'Listening Room', 'Dubbing Theatre/Mixer Room/Film Cutting Room' and 'All Television Control Rooms' were assumed to have the same maximum sound pressure levels as the cubicle for a Radio orchestral music studio. The rationale behind this assumption was that, being either general purpose radio areas or television areas and therefore implicitly general purpose, they might all at some time be required to process the sound for an orchestral music production. Whatever the operational forces and needs which require the use of certain levels of sound in a Radio cubicle by the studio managers are, they are equally applicable to these other areas. (This argument could equally have employed the case of a Radio 'pop' cubicle but it was felt, at the time, unreasonable and uneconomic to aim for the most stringent case and that the second most stringent case would be a suitable compromise.) The author still believes that the lower sound pressure levels encountered in some television areas result not from any implicit intent or desire to use lower sound levels but are effectively imposed by the generally inferior sound insulation standards which have been the rule in television. It is therefore the author's opinion that adopting the existing sound pressure levels for the determinants in a sound insulation criterion only serves to perpetuate the present situation which, in Television Centre at least, is a source of complaints from the operational staff. Nevertheless, the author has been prevailed upon to include measurements of the present situation as the determining factors in the calculation of revised sound insulation criteria for these areas. The category 'Television Sound Control Rooms' alone has been excluded from this reduction.

* by A.R. Woolf.

The same assumptions made previously in PH221 have been made again for Sound Control Rooms.

However, for the other Television Control Rooms, there is no doubt that they do not require the same high acoustic standards as the Sound Control Room. Accordingly, reduced sound insulation standards are to be applied to all television control rooms, except that for the sound.

2.6 Other changes

The derivation of the sound insulation chart has been computerised, whereas the original chart was derived graphically. This may cause small differences in the sound insulation criteria which have not been intentionally changed for any of the reasons given above. Because of the way the criteria are presented (as intersections between lines of different slopes), these differences may appear to be larger than they really are, in that two similar criteria could be described by two superficially quite different sets of numbers, although most are not. The computer calculation also means that any individual computational or transcription errors in the original PH221 chart have been eliminated.

2.7 Confirmation of noise sources

Since the preparation of PH221, additional opportunities to measure road traffic and aircraft noise have arisen. These have again confirmed the existing figures for traffic noise in city streets.

For aircraft noise, a set of figures which has recently become available⁷ indicates that the figures previously used in PH221 for the noise produced by overflying aircraft are reasonable. According to this data, the existing figures in PH221 are adequate for protection against relatively modern aircraft (medium-size, civilian-type, non-bypass jet transport) on full power at a slant distance of not less than 1500 m.

3. DETAILS OF CHANGES

3.1 'Own Control Room/Cubicle' criteria

One of the principal reasons for the initiation of this review of the sound insulation criteria was the belief that it was necessary to reinstate the earlier category for the requirements between a studio and its own control area. In the event, as described above, the general acceptance of a similar overall five decibel relaxation in the criteria for all area types effectively removed the justification for any special category.

The extensive studies which were carried out into the arguments which might have led to a

theoretically valid 'own cubicle' criterion have not ultimately been incorporated into the final criteria. They are reproduced in this Report as Appendix 2 in order to record them and in case any future reconsideration of the sound insulation requirements necessitate their reincarnation.

3.2 Television machine rooms

A sample survey was carried out to establish the maximum sound pressure levels generated in television machine rooms. These are generally defined as areas in which recording or replay of programme material takes place but in which there is no requirement for quality monitoring or facilities for influencing the recorded sound quality. A total of 19 measurements, each recording about 10 minutes of continuous sound, were made, eight in TK32 Transmission Suite and 11 in Transmission Suite 1 (VT). Analysis of the peak sound pressure level in each $\frac{1}{3}$ rd octave frequency band was carried out on these recordings. For compatibility with the other sound level data used to derive insulation criteria, the composite spectrum consisting of the highest sound pressure level in each frequency band was converted to octave bandwidth. The values used for the source sound pressure levels for these areas in the calculation of the sound insulation criteria are given in the table in Appendix 1.

For the calculation of sound insulation between two such areas it has been assumed that the same background noise criterion as for a general office (NR 45) would be appropriate. As with the offices and other ancillary areas, for economic reasons no allowance has been made in the main chart for protecting these areas from the studio areas.

3.3 Television editing areas

As stated in Section 2.2 above, it has become necessary to include an entry in the sound insulation criteria chart for television editing areas. The same kind of survey was carried out as for television machine rooms and the same kind of analysis made. 11 recordings were made in VT 14 Editing Suite and six in VT Editing Suite F. The results for the source sound pressure levels of these areas are also given in the table in Appendix 1.

Because these are areas in which critical sound assessments are carried out, the background noise criterion for all television studio areas should apply to these areas also. They should therefore conform to criterion 'ii', and the sound insulation criteria have been calculated accordingly.

The same source sound pressure level data has been used for the existing category of 'Dubbing

Theatre/Mixer Room/Film Cutting Room' because the activities in that category are similar to tape editing. Also, in line with the reduction of acoustic standards in all television control areas except the Sound Control Room, these same source sound pressure levels have been assumed for all other television control rooms.

3.4 Private offices with monitoring facilities

A survey was carried out of the maximum sound pressure levels in 'Private Offices' with facilities for disc or tape replay. These are typically the offices of music or current affairs producers who audition the material in their office rather than in a listening room. The previous survey, when PH221 was first compiled, used Radio 1 offices as examples. This more recent survey included two measurements in Radio 1 offices as a repeat and eight in the less severe Radio 2 and Radio 4 conditions.

These recordings were analysed in the same way as for TV machine rooms and editing areas. For the repeat of the Radio 1 offices, the average difference between the present and the previous results was a remarkably small 0.8 dB! The maximum difference in any frequency band was only 4 dB. For the other offices, that is, three Radio 2 producers' offices and the "Pick of the Week" office, the maximum sound pressure levels were 10 dB lower on average. At the low frequency end of the spectrum, where sound insulation is expensive, the difference was 13 dB at 63 Hz and 17 dB at 125 Hz.

These revised peak sound pressure levels have been used to calculate the sound insulation criteria. However, as stated in Section 2.4, the sound insulation criteria are now misleading in that the high sound pressure levels which have been confirmed to exist in some offices are no longer allowed for in the main criterion chart. This is a more dangerous situation than if the worst-case levels had been used. Whereas apparently excessively high values of insulation criteria might cause questions to be asked during the design of a building, thereby uncovering the reasoning, values which might actually be too low will not be questioned. A note giving a warning about this danger has been added to the criterion chart.

3.5 Listening Rooms

The data for the peak source sound pressure levels in Listening Rooms in PH221 was taken to be the same as the cubicle to an Orchestral Music studio by the same reasoning as for the television areas as described in Section 2.5. This is now felt by some to be too stringent and a sample survey of sound pressure levels was carried out in existing Listening Rooms.

The data were processed in the same way as in Section 3.4 above to extract the peak spectrum.

When compared with the data previously assumed for PH221, the more recent levels are an average of 17 dB lower. In terms of building construction this is a very significant change. These measured sound pressure levels have been used to calculate the sound insulation criteria.

The question again arises of how much this approach reflects the wishes of the users compared with the perpetuation of the *status quo*.

4. CALCULATION OF THE SOUND INSULATION CRITERIA

4.1 Main chart

The entries in the revised sound insulation criterion chart, Table 1, were calculated in the same way as was originally done for PH221, using the 'new' data as described in Section 3 above, where appropriate.

A brief description of the method of calculation is as follows:

- a) For each pair of possible areas the sound insulation required at each octave-band centre frequency is calculated by subtracting the background noise level in one area from the source sound pressure level in the other area. For most pairs of areas this is done for both directions of interference and the largest value taken at each frequency. In some cases, either where there is no requirement for insulation in one direction or if for economical reasons it has been decided that the protection against interference should apply only in one direction, the sound pressure level difference for that direction is used alone.
- b) The resulting composite spectrum of differences thus derived is used to determine the insulation values required of four different wall constructions having characteristic slopes of 15, 10, 8 and 5 dB/octave, each of which will just satisfy the requirement. These slopes correspond to idealised wall constructions of different types (large cavity triple leaf, large cavity double leaf, small cavity double leaf and single leaf).
- c) From these idealised wall requirements a composite criterion is derived by specifying the levels of the intersections of the lines and the

value required at the lowest frequency band (63 Hz). As a check for the users of the criterion that it has been reconstructed properly, the frequency at which the slope becomes 0 dB/octave is also given.

In this way, a composite criterion is derived which retains most of the shape of the actual sound insulation requirement and yet is closely related to the performance (admittedly idealised) of real partitions. The building designer can make an informed choice of partition type and performance.

Some areas such as 'Private Offices', on the basis of the above general analysis, could be subject to interference from studio areas. As in PH221, it was decided that to protect unimportant areas from the sound levels produced in programme areas would generally be uneconomic. In those cases, therefore, the insulation criterion in the main chart is for one direction only. Also as in PH221, a subsidiary chart has been provided for the omitted data. This subsidiary chart gives the bi-directional sound insulation criterion for those areas where, for economic reasons, it would be normal to protect only the programme area *and* where the bi-directional criterion is the more stringent.

5. DETAIL CRITERIA

5.1 Main chart

Table 1 shows the revised sound insulation chart, calculated as described in the preceding sections and using mostly the same data as for the original chart in PH221. The only differences are those described in Section 3 above, namely the omission of the 'Reverberation Plate Room' and the 'Echo Room' categories, the addition of the categories for 'TV Machine Rooms' and 'Editing Suites and TV Sound Control Rooms', the updating of the data for the categories 'Listening Room' and 'Private Offices with Monitoring Facilities' and other control rooms and the revision of the non-programme area background noise criteria. Like PH221, the main chart does not allow for the protection of ancillary areas from the studio areas.

Several additional notes have been added to the chart. Notes 1 and 2 appeared on the original chart in PH221 and define some restrictions on the application of the criterion values. Note 3 specifies that, in most normal circumstances, up to 5 dB may be subtracted from the criterion values to give results which have generally been found to be acceptable. Note 4 gives a warning that some extreme cases are not represented on the chart.

5.2 Subsidiary chart

Table 2 is the subsidiary chart showing the higher sound insulation levels required to give protection to ancillary areas against interference from programme areas. In this case, some of the notes also differ from those on the main chart. It is expected that these values for sound insulation will never actually be required or justified in practice. They are given for completeness only.

5.3 Use of the chart

In practice the use of the chart is relatively straightforward. For pairs of area categories which are directly represented, it is simply necessary to look up the group of six figures at the intersection of the relevant row and column. The criterion can be reconstructed by beginning at the point 63 Hz, D_{63} and constructing a line at a slope of 15 dB per octave up to the value $D_{15,10}$. The line is then continued at slopes of 10, 8, and 5 dB per octave through the values $D_{10,8}$, $D_{8,5}$ to the value $D_{5,0}$ at which point the frequency should be f_0 Hz. f_0 is actually given on the chart as $f_0/100$.

The reconstructed criterion may be compared with the known performances of different partition types until a satisfactory match is found.

If one or both of the areas is not directly represented on the chart then there are two options. Either similar categories can be chosen from the chart or the requirement calculated from a knowledge of the source sound levels and background noise level requirements. In the former case, it is important that the equivalents chosen are alike in source sound level and background noise level requirements. Because of the composite nature of the criteria, it is not always easy to make allowances for differences in these factors. In the latter case, the result is an actual requirement which can be used directly rather than being used to produce a criterion-like idealization.

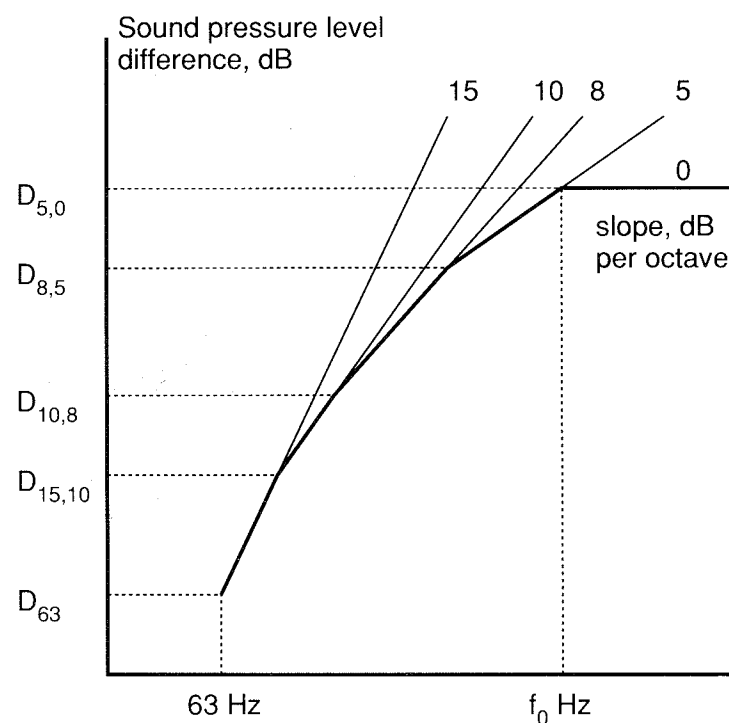
6. TOLERANCES

6.1 General

The previous sound insulation criterion document, PH221, had very little data on the tolerances which would be acceptable in practice. Following the Acoustics Committee's recommendation that the criteria should be based on the 'peak' levels of the source sound pressure levels, there are indeed no tolerances which could be applied, at least not in the sense of shortfalls. Despite this recommendation, PH221 does contain a small allowance for such shortfalls, viz "*... a shortfall of about 3.5 dB might be*

NOTES

1. For protection of the internal area from external sound. The requirements for areas needing exterior noise control may be different.
2. For protection of the programme areas only. Additional insulation may be required for protection of other areas from programme sound, if required.
3. The figures given are for complete protection. In most cases, 5dB may be subtracted from the specified insulations to give conditions which have been found to be generally acceptable.
4. Figures based on 'Light'/'Classical' music. 'Pop' music producer's offices may have levels up to 17 dB higher at 125 Hz.



D_{63}	$D_{15,10}$
$D_{10,8}$	$D_{8,5}$
$D_{5,0}$	$f_0/100$

2. For protection of the programme areas only. Additional insulation may be required for protection of other areas from programme sound, if required.

4. Figures based on 'Light'/'Classical' music. 'Pop' music producer's offices may have levels up to 17 dB higher at 125 Hz.

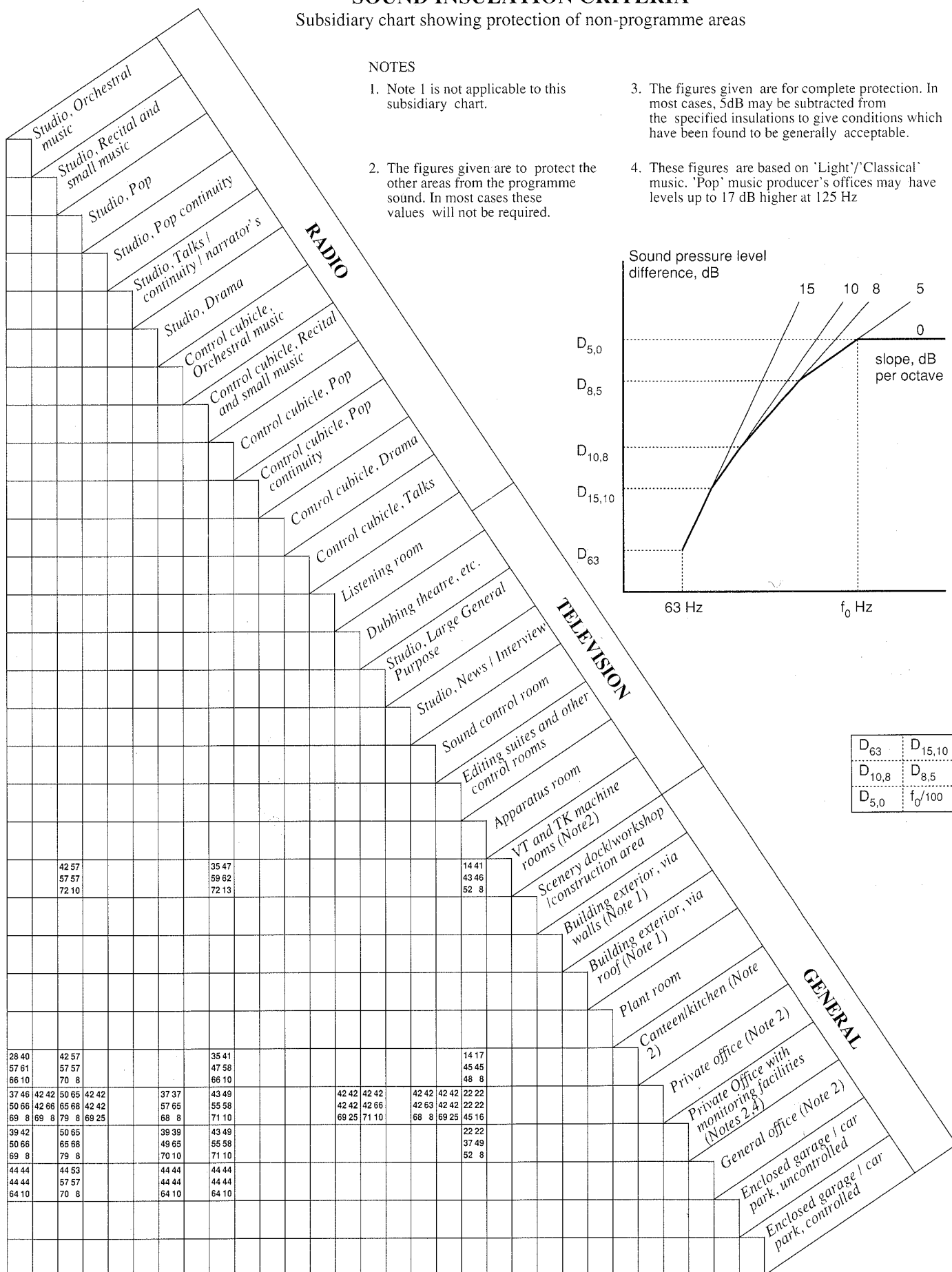
Room / Space	D ₆₃	D _{15,10}	D _{10,8}	D _{8,5}	D _{5,0}
Studio, Orchestra	51	66	66	82	87
Studio, Recital and small music	56	71	83	87	90
Studio, Pop	66	81	86	89	91
Studio, Pop continuity	66	81	86	89	91
Studio, Talks / continuity / narrator's	56	71	83	87	90
Studio, Drama	56	71	83	87	90
Control cubicle, Orchestra music	61	76	81	84	87
Control cubicle, Recital and small music	61	76	81	84	87
Control cubicle, Pop	56	71	83	87	90
Control cubicle, Pop continuity	56	71	83	87	90
Control cubicle, Drama	60	75	80	83	86
Control cubicle, Talks	56	71	83	87	90
Listening room	56	71	83	87	90
Dubbing theatre, etc.	56	71	83	87	90
Studio, Large General Purpose	56	71	83	87	90
Studio, News / Interview	56	71	83	87	90
Sound control room	56	71	83	87	90
Editing suites and other control rooms	56	71	83	87	90
Apparatus room	56	71	83	87	90
VT and TK machine rooms (Note 2)	39	42	44	44	44
Scenery dock/workshop / construction area	29	34	36	36	36
Building exterior, via walls (Note 1)	32	38	37	37	37
Building exterior, via roof (Note 1)	47	52	52	52	52
Plant room	41	46	46	46	46
Canteen/kitchen (Note 2)	35	40	40	40	40
Private office (Note 2)	58	63	66	66	66
Private Office with monitoring facilities (Notes 2, 4)	62	67	70	70	70
General office (Note 2)	39	44	44	44	44
Enclosed garage / car park, uncontrolled	44	49	49	49	49
Enclosed garage / car park, controlled	44	49	49	49	49

SOUND INSULATION CRITERIA

Subsidiary chart showing protection of non-programme areas

NOTES

- Note 1 is not applicable to this subsidiary chart.
- The figures given are to protect the other areas from the programme sound. In most cases these values will not be required.
- The figures given are for complete protection. In most cases, 5dB may be subtracted from the specified insulations to give conditions which have been found to be generally acceptable.
- These figures are based on 'Light'/'Classical' music. 'Pop' music producer's offices may have levels up to 17 dB higher at 125 Hz



tolerated in some circumstances . . .". This allowance was based on the average difference, for all studio types, of approximately 3.5 dB between the highest measured level and the level which was exceeded for 1% of the time.

Since PH221 was prepared and primarily because of the increasing use of external acoustic consultants, it has been necessary to prepare a more formal set of tolerances which do recognise the realities of building construction and financial constraints. Even then, these tolerances permit very little overall shortfall but do allow for larger localised departures from the ideal in accordance with reasonable practical experience. They were originally produced as an Acoustics Committee Note⁸ and, for the sake of completeness, the section on tolerances is reproduced here:

6.2 Programme areas

There is no acoustic penalty in values of sound insulation which exceed the criterion. Accordingly, all tolerances are specified in terms of adverse deviation which is defined as the criterion minus the achieved sound insulation. It is set equal to zero if it would otherwise be negative.

In setting these tolerances it is recognised that there are difficulties in the design of partitions and the measurement of sound insulation at low frequencies. Accordingly, the tolerances have been divided into two frequency bands.

The permitted tolerances for areas in which programme making or critical assessment of sound quality are carried out (these include all areas covered by background noise criteria (i), (ii) and (iii), by criteria derived relative to them or other critical area criteria as specified) are as follows:

Low frequencies

In the frequency range 63 Hz to 200 Hz the average of the adverse differences shall be less than 6 dB and no individual adverse deviation shall exceed 10 dB.

High frequencies

In the frequency range 250 Hz to 10000 Hz the average of the adverse differences shall be less than 2 dB and no individual adverse deviation shall exceed 5 dB.

6.3 Non-programme areas

Non-critical areas have larger tolerances for sound insulation. However, this relaxation applies only if both of the areas fall outside the definition of *critical area*. In these cases the tolerance is that no adverse difference shall be greater than 10 dB.

7. CONCLUSIONS

The BBC sound insulation criteria, which were last revised in 1981, have been reviewed mainly in order to establish whether they are still valid and relevant. Because those criteria were so stringent and because of changing circumstances, this review was necessary to attempt to find methods of reducing the requirements by perhaps making more appropriate category subdivisions. One of the main objectives was to discover whether the previous category relating to the sound insulation between a studio and its own control room, which had been dropped in the 1981 revision, could usefully be reinstated. This is an important category which, because of the frequency of its occurrence, may account for about half of the total number of sound insulation specifications raised.

The outcome of this review was the confirmation that the 1981 criteria are still mostly valid and appropriate, although the opportunity has been taken to ensure that the categories more closely represent current practice. Some categories have been dropped as obsolescent and some new ones inserted. Some categories have been revised as being too stringent for general use, although the 1981 standards will continue to be required in some special cases. The opportunity was also taken to generate the criteria charts entirely by computer, to remove a small number of transcription errors. Overall, a study of achieved sound insulations and users' responses indicated that a 5 dB relaxation from the formal criteria would be generally acceptable without causing excessive numbers of either retakes, levels of users' complaints or substandard programmes. It should be noted that this relaxation will, by definition, lead to audible airborne interference from adjacent areas.

Regarding a proposal to reinstate the 'Own control room' criterion, a more detailed study of achieved sound insulations and users' responses carried out by Radio Capital Projects showed that the same 5 dB was allowable. Thus, the justification for including this requirement as a separate category was removed.

8. REFERENCES

1. SMITH, T.J.B. 1968. Airborne sound insulation requirements in broadcasting studio centres. BBC Research Department Report 1968/35.
2. WALKER, R. 1981. Revision of the sound insulation requirements in broadcasting studio centres. BBC Research Department Report No. BBC RD 1981/1.

3. MEARES, D.J. 1973. Statistics of typical programme sound pressure levels in sound studios and their control rooms. BBC Research Department Report No. BBC RD 1973/37.
4. WALKER, R. 1978. Probability levels of sound interference between programme areas. BBC Research Department Report No. BBC RD 1978/25.
5. ROBINSON, A.P. 1978. The masking effect of background noise. BBC Research Department Report No. BBC RD 1978/3.
6. ISO Recommendation R 1996. Assessment of noise with respect to community response. International Standards Organisation.
7. Private communication.
8. BBC Acoustics Committee Note No. 1988/1.
9. MUNCEY, R.W., NICKSON, A.F.B. and DUBOUT, P. 1953. The acceptability of speech and music with a single artificial echo. *Acoustica*, 1953, 3, pp 168-173.
10. CROMPTON, T.W.J. 1972. Studio to cubicle insulation requirements with delayed monitoring. BBC Research Department Report No. BBC RD 1972/38.

APPENDIX 1

Database

This Appendix contains the data on which the sound insulation requirements and the criteria have been based. The data for studio areas is as in PH221 and derived from Ref. 3. Most of the other areas are also as in PH221, the exceptions being 'Listening Room', 'Dubbing Theatre etc.', 'Editing Suites' and 'VT and TK Machine Rooms'.

Source sound pressure levels (dB re 20 μ Pa)

Area	Frequency Band (Hz)							
	63	125	250	500	1k	2k	4k	8k
Studio, Orchestral Music	97	103	103	105	104	100	95	91
Studio, Recital and Small Music	86	92	102	105	102	97	90	85
Studio, 'Pop'	112	118	116	115	114	110	105	102
Studio, 'Pop' Continuity	90	94	95	95	94	90	87	80
Studio, Talks/Continuity/Narrator's	73	81	84	85	80	77	72	68
Studio, Drama	73	73	81	81	76	73	67	66
Control Cubicle, Orchestral Music	98	99	101	104	102	98	92	85
Control Cubicle, Recital and Small Music	71	79	87	89	84	82	75	68
Control Cubicle, 'Pop'	106	108	104	105	101	102	97	81
Control Cubicle, 'Pop' Continuity	81	90	88	88	85	81	78	73
Control Cubicle, Drama	71	82	87	88	85	80	74	67
Control Cubicle, Talks	71	78	82	81	78	75	69	62
Listening Room	81	83	82	84	84	82	74	72
Dubbing Theatre, etc.	88	88	94	86	84	79	76	71
Studio, Large General Purpose	97	103	103	105	105	100	95	91
Studio, News/Interview	73	81	84	85	80	77	72	68
Sound Control Room	98	99	101	104	102	98	92	85
Editing Suites and other Control Rooms	88	88	94	86	84	79	76	71
Apparatus Room	85	76	73	70	69	70	71	72
VT and TK Machine Rooms (Note 2)	75	79	88	88	80	81	82	74
Scenery Dock/Workshop/Construction Area	78	80	83	85	85	85	85	80
Building exterior, via walls (Note 1)	93	92	93	92	93	92	90	0
Building exterior, via roof (Note 1)	87	87	87	81	81	81	81	0
Plant Room	81	81	87	87	87	88	88	88
Canteen/Kitchen (Note 2)	74	75	79	84	82	76	77	71
Private Office (Note 2)	83	74	71	68	67	68	69	70
Private Office with monitoring facilities (Notes 2, 4)	85	85	84	88	87	83	72	68
General Office (Note 2)	90	83	79	77	74	74	74	68
Enclosed Garage/Car Park, uncontrolled	86	100	100	95	93	90	86	76
Enclosed Garage/Car Park, controlled	80	74	69	69	63	62	61	60

Background noise criteria (dB re 20 μ Pa)

Criterion i	46	37	29	23	18	14	11	7
Criterion ii	41	32	24	18	13	9	6	2
Criterion iii	36	27	19	13	8	4	1	0
Private Office (NR 35)	63	53	45	39	35	32	30	28
General Office (NR 45)	71	61	54	49	45	42	40	38

APPENDIX 2

Derivation of 'Own Cubicle' Criteria

This Appendix was originally part of Sections 3, 4 and 6 of the main Report, until overall revisions made the contents redundant for the present purpose. However, it is felt that the work still has some value and is worth including as an appendix, in case the arguments have to be revived in the future.

A2.1 Background information

The required sound insulation criterion for the 'own cubicle' case is not easy to establish with any degree of confidence. Whereas the other criteria are numerical differences, based relatively firmly on sets of numbers representing sound pressure levels together with psycho-acoustic factors, there is no such simplification for the 'own cubicle' case. Six factors may influence the amount of sound insulation required, bearing in mind that, by definition, the interference will be audible:

- a) If the monitoring in the control cubicle is 'off tape' there will be a time delay in the acoustic interference from the cubicle to the studio. It is well-known that delayed sound causes more disturbance than undelayed sound.
- b) Even if the monitoring in the cubicle is direct there will still be some limit to the acceptable interference beyond which the quality of the perceived sound will be changed.
- c) There will be some limit to the sound insulation below which the microphone signal from the studio, when amplified and reproduced on the cubicle loudspeaker(s) and then attenuated by the partition will produce a sound pressure level at the microphone which is greater than it was originally. This is a feedback path known as 'howlround'.
- d) Unlike the other sound insulation criteria, the above three limits depend directly on the relative levels of the reproduced sound in the cubicle and the source in the studio. For this reason, if not any other, different programme types of studio/cubicle combinations will have different criteria.
- e) There may be a psychologically necessary amount of sound insulation which is required to satisfy the users of the areas and to give them confidence that the insulation is adequate. This may be different to that required on purely numerical acoustic criteria. For example, occasional random noises such as the crashing of tea-cups or dropping of a tape-reel will not be allowed for by the criteria (a) to (d) above and may cause unacceptable disturbance. It may also be necessary to provide a degree of 'confidentiality' between studio and cubicle to permit conversations in the cubicle which cannot be heard in the studio.
- f) There may be reasons why the insulation in one direction, say from the studio to the cubicle, may be required to be different to that in the other direction.

In the following sub-sections (A2.2 to A2.4) attempts are made to establish values for some of these factors. Because of the dependency on the studio/cubicle level difference (item 'd' above), the case where the level difference is zero has been taken for the purposes of discussion. This is representative of a wide range of programme types, but not all. Detail criteria will be given in a later section (Section A2.7).

A2.2 Delayed monitoring

Very little data is available on the audibility of delayed echoes, especially as a function of spectral distribution. Ref. 9 describes some earlier work and gives threshold values of echo level, relative to the main sound, for different time delays. The criterion was of 'disturbance' by the echo. No frequency data are given so it may be assumed that the echo was wideband. The performance of the equipment is given as '60 Hz to 8 kHz'. For a delay of 150 ms, corresponding to a typical sound tape recorder at 15 in/s, 20% of the observers were 'disturbed' by an echo level of -10 to -30 dB depending on the programme type. Speech at a 'fast tempo' was the most critical material tested. In translating to a 'perceptibility' criterion, about 5 dB per grade could be subtracted from these levels, giving -20 to -40 dB. It is, of course, impossible to extrapolate over such a period of time and in different circumstances with any degree of confidence.

Ref. 10 gives the results of some (slightly) more recent BBC work which does contain some frequency dependent data. In this work, tests were carried out using simulated partition insulations corresponding to three different wall constructions, with different frequency dependencies of sound insulation. The single echo was fixed at 90 or 180 ms and the subjects asked to determine the threshold of perceptibility of feedback from a loudspeaker whilst they were talking. The results are very roughly in agreement with those of Ref. 9. A subsidiary series of tests was also carried out to determine the threshold of perceptibility of echoes with reproduced sound, i.e. where both main signal and the echo were generated by loudspeakers. This has relevance for the studio to cubicle insulation direction (see Section A2.6).

The results in Ref. 10 are presented in the form of histograms showing the percentage of observers who classified the echo as 'just not perceptible' for different ratios of main-to-echo sound pressure levels. Furthermore, the level ratio given is at the nominal reference frequency of 235 Hz. For this present purpose it is more convenient to treat the data as an equivalent sound insulation characteristic. Therefore, the ratio at which 50% of the observers judged the echo to be 'just not perceptible' was taken and the equivalent partition insulation reconstructed. Fig. A2.1 shows the results obtained, presented in that way, for the three different partition types tested and a delay of 180 ms. The values for the 90 ms delay were consistently 8 dB lower (i.e. less critical).

Despite its appearance, Fig. A2.1 does not give very much information about the frequency dependency of this threshold. Consider a frequency at which all of the equivalent partitions have an excess of sound insulation over the threshold of perceptibility. This is not shown by Fig. A2.1. Therefore, it is reasonable to take, at each frequency, the lowest of the three lines as the threshold. Even this is probably not the level of the threshold at high frequencies because all of the partitions may have excess sound insulation there. Subjectively, the threshold of audibility is likely to have the same form as the ear's sensitivity curve at the appropriate sound pressure level. But which is the 'appropriate level'? Since the echo is being heard at nearly the same time as the sound is being generated, it is obviously not the background noise level or even the level at which the echo would be heard alone. Equally, because the echo is definitely delayed, it is not the level at which the main sound is being generated. Attempts to fit inverted ear sensitivity curves to the lines of Fig. A2.1 showed that the 60 phon curve gives the best fit, as shown in Fig. A2.2. Appropriately, the 60 phon curve is approximately half-way between the main source spl of 80 dB re 20 μ Pa and the echo spl, at this level of simulated insulation, of 40 dB re 20 μ Pa.

As a prospective criterion, this curve has two desirable characteristics. Firstly, it is violated by the three equivalent sound insulation lines of Fig. A2.1 if any of them were to be reduced in level (just as in the experimental work). Secondly, it remains constant in level above about 500 Hz/46 dB, just as experience dictates

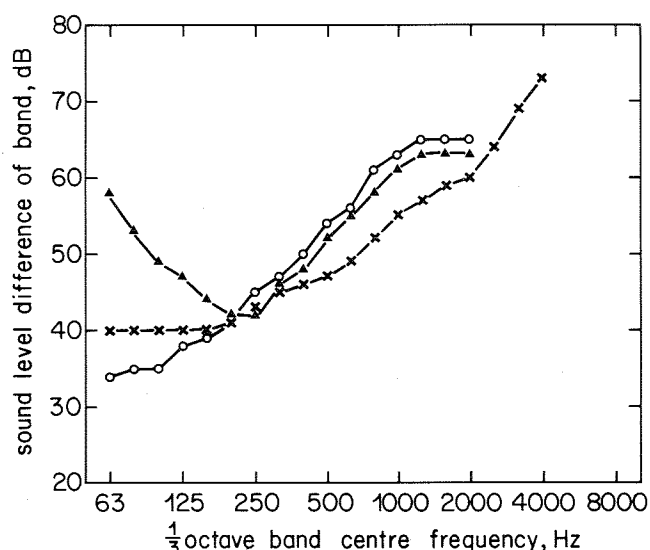


Fig. A2.1 - Equivalent sound insulation characteristics of the three partitions simulated in Ref. 10.

that it should. It is therefore a reasonable candidate for the delayed monitoring criterion, for the case where the cubicle and the studio sound pressure levels are equal, and where there is no other higher level limitation. If the cubicle sound pressure level is usually higher then that difference must be added to the criterion. For example, Talks studios have average levels in the cubicle which are 5 dB higher than the studio, therefore the required insulation criterion is 5 dB higher at every frequency.

The supplementary tests of Ref. 10 showed that the threshold of perceptibility of delayed echoes was less by about 6 dB for all conditions when both of the test signals were generated by loudspeakers. Translating this to the insulation requirements, the sound insulation required from the studio to cubicle is less by 6 dB than in the reverse direction. Thus, only if the studio sound pressure level is typically more than 6 dB higher than in the cubicle will this be a limiting factor. Music studios of all types usually come into this category.

A2.3 Undelayed monitoring

There is even less data available for audibility of 'undelayed' echoes. 'Undelayed' in this context means no intentional delay. There is, of course, the inevitable propagation delay, of about 20 ms in a small studio/cubicle and up to perhaps 100 ms in a large studio. At the upper end of this range there is an obvious overlap with the conditions of Section A2.2 above. Ref. 9 does not cover very short delays, but extrapolation indicates about -10 dB for 20% disturbance and for a 20 ms delay. Making an allowance for the difference between perceptible and disturbing gives about -20 to -25 dB.

Informal subjective tests in Kingswood Warren Listening Room 2 showed that, when it was set up as a studio with the same reproduced level in the cubicle as in the 'studio', it was only marginally acceptable. With any increase in reproduced level, it became immediately apparent in the studio that there was an echo from the cubicle loudspeaker. The time interval of this echo (obtained geometrically) was about 20 ms. Three independent observers were able to identify whether or not the feedback loop was functional at that level. The measured airborne sound insulation in this case was as shown at (a) in Fig. A2.3, with an average of about 30 dB over most of the frequency range. This must represent close to the minimum acceptable sound insulation without deliberately delayed monitoring. Adopting the same hypothesis about the ear's sensitivity as in Section A2.2, gives the requirement as shown at (b) in Fig. A2.3, again for the case where the sound pressure levels in the studio and the cubicle are the same.

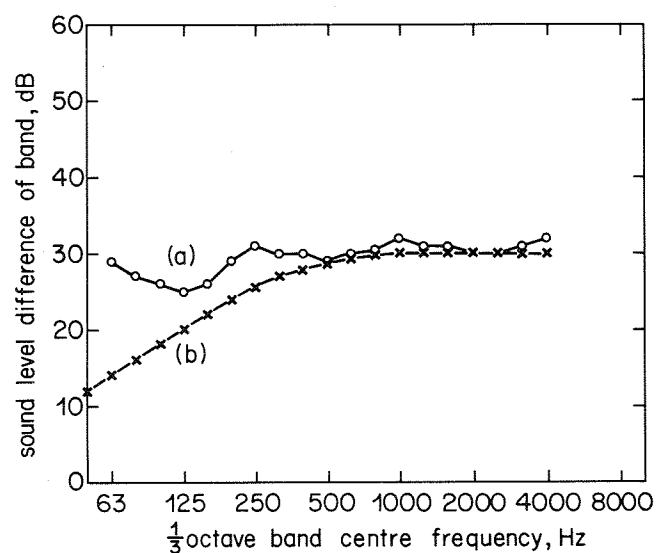
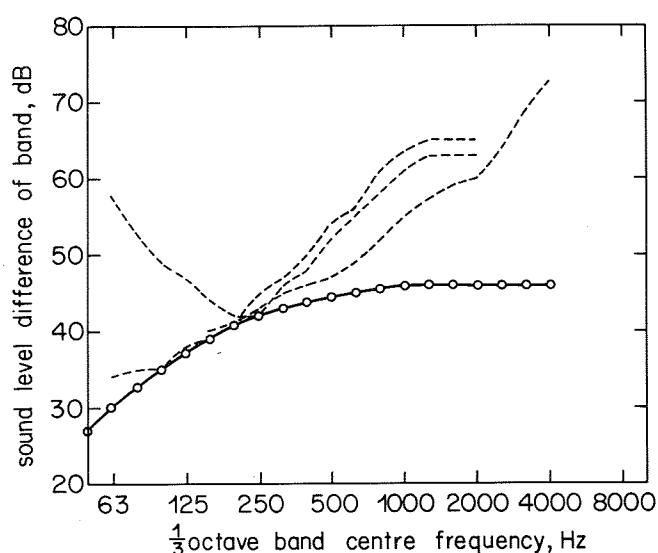


Fig. A2.2 - Equivalent sound insulation characteristics of the three partitions simulated in Ref. 10, compared with the proposed 'Own Cubicle' criterion for delayed monitoring.

- Inverted 60 phon sensitivity curve
- Simulated sound insulation characteristics

Fig. A2.3 - Kingswood Warren Listening Room 2.

- (a) Measured 'studio' - cubicle sound insulation
- (b) Insulation approximated by 60 phon response shape

A2.4 Howlround

Howlround was defined above, in Section A2.1. The gain margin before the onset of howlround, that is, the amount by which the gain of the loop can be increased before the system begins to oscillate can be called the howlround margin. One reason why the howlround margin is not the same thing as airborne sound insulation is that howlround is essentially a narrow-band phenomenon whereas sound insulation is usually measured at least in $\frac{1}{3}$ rd octave, and sometimes even wider, frequency bands. The relatively smooth curves provided by such sound insulation measurements do not represent the behaviour of a pair of rooms and a partition in detail. The presence of room modes with a peak of sound pressure level at the microphone position can seriously affect the potential for howlround.

The loop gain, and hence the howlround margin, depends directly on the studio microphone and cubicle loudspeaker gain settings and will therefore vary from day to day according to individual preferences in these matters. It also depends, to some extent, on the microphone position (see below) and on the effective sound insulation of the partition, but these are less subject to individual preference, particularly the latter.

A measurement made in Kingswood Warren Listening Room 2 was carried out using a narrowband spectrum analyser to measure the loop gain when the room was set up as described in Section A2.3 above. The results showed that a margin of about 17 - 18 dB existed, being essentially independent of frequency. This independence was mostly a result of the airborne sound insulation being rather poor and also essentially independent of frequency, as shown in Fig. A2.3(a). Although the magnitude of the howlround margin at its worst frequency varied by about 10 - 15 dB with microphone position, when the phase was included the real part of the loop gain, also at its worst frequency, showed only 1 - 2 dB variation. The measured worstcase howlround margin of 17 dB should be compared with a conventionally measured airborne sound insulation of about 25 dB at the same frequency.

A2.5 Summary

Although formal subjective tests were not carried out, it seemed that the echo of the sound as perceived by a speaker in the studio was a more significant limitation than the actual onset of howlround. For this particular arrangement the frequency at which the howlround was least was about 65 - 70 Hz, depending on the microphone position (when the loop gain was increased oscillation occurred at that frequency). With the gain at the 'normal' setting and a measured worst-case margin of about 18 dB and with many other peaks approaching 30 dB margin, it was possible to detect the presence of the feedback loop. Moreover, this subjective effect was a wideband one, not exclusively confined to the frequencies close to that of the worstcase margin.

With this arrangement, there was no detectable effect on the reverberation time in the 'studio'. It was necessary to increase the loop gain to very close to the onset of oscillation before any definitely noticeable change occurred in the reverberation characteristics of the room, thus illustrating incidentally how difficult it is to modify the reverberation time of a room electronically.

In other circumstances, for example with loudspeakers which are more effective at the lower frequencies, it is possible that very low frequency howlround could occur without there being any subjective effects. It is believed that such cases have occurred and oscillation frequencies of about 22 Hz have resulted. If the howlround is outside the frequency range of interest for broadcasting (and incidentally the range for which sound insulation is specified) then the simplest solution is a high-pass filter.

These results indicate that, for cases where the sound pressure level in the control room is the same as in the studio, the minimum acceptable isolation over the whole of the normal audio frequency range is not dependent on the howlround effects. Compared with the airborne sound insulation as measured in the usual way with $\frac{1}{3}$ rd octave band analysis, the howlround margin may be about 10 dB lower at some frequencies. Therefore, a minimum airborne sound insulation of 20 dB should give a safety margin of 10 dB to allow for operator variations and other day-to-day preferences. This applies to the 'standard' condition of equal sound pressure levels in the cubicle and the studio. Allowance has to be made for other conditions.

Howlround at frequencies outside the normal broadcasting range may occur because of peculiarities in the sound insulation outside the frequency range of specification and through the use of loudspeakers with extended bass responses.

A2.6 Calculation of the 'Own Control Room/Cubicle' sound insulation criteria

For the category 'Own Control Room/Cubicle' a subsidiary table, consisting of only two sets of criterion figures together with a list of correction factors for different circumstances, is a more convenient form. Two sets of figures are required to cover the with/without delayed monitoring conditions. For the delayed monitoring condition, the sound insulation requirement will also depend on the length of the delay. The table has been calculated for a delay of 180 ms, based on the work described in Ref. 10, as interpreted in Section A2.2 above. Allowance can be made for shorter delays, down to about 90 ms, by linear interpolation at a rate of 8 dB for 90 ms (i.e. approximately 0.1 dB per ms). Outside those delay times, there is no information on which to base any criteria.

In large studios the delay time may approach the lower end of the 'delayed monitoring' category even if no such deliberate delays are envisaged. In such cases, only the figures for the delayed monitoring should be used.

The sound insulation requirements of the different categories of studio types are represented by the tables in Section A2.7. The corrections to be applied to the basic set of criterion figures have been obtained by taking into account the factors of delayed/undelayed monitoring and the studio/cubicle sound pressure level differences. These level differences were derived by averaging the studio and the cubicle sound pressure levels obtained from the source data for PH221³. The criteria are subject at all times to a minimum value of 20 dB to avoid the possibility of howlround. Furthermore, this minimum value also applies outside the frequency range over which the criteria are usually specified, that is, those octave frequency bands centred on 63 Hz to 8 kHz.

The corrections for the relative level difference have been obtained as follows:

- (1) If the average studio sound pressure level is lower than the cubicle then this difference should be added to the insulation requirement — reason: the limiting criterion is the perceptibility of the echo in the studio.
- (2) If the studio level is higher than the cubicle level but the difference is less than 6 dB then the criterion should stand unchanged — reason: as in (1).
- (3) If the studio level is higher than the cubicle level and the difference is greater than 6 dB then the criterion should be increased by the difference in levels minus 6 dB — reason: the limiting criterion is perceptibility of the echo on the cubicle monitor, 6 dB less sensitive than in the studio (see Section A2.2).

It should be noted that these differences are not based solely on the peak sound pressure level data given in Appendix 1. For this analysis, it has been necessary to include the 'typical' sound pressure level data in addition to the peak because the worst case difference in the levels between studio and control room does not necessarily occur at the highest levels. Unlike the rest of the sound insulation criteria, this 'own control room' criterion is relative and dependent on the difference rather than the absolute levels.

It is clear that the 'Own Control Room' criteria are very much less clearly defined than are the other sound insulation criteria. This is partly a result of the highly subjective nature of clearly audible interference (as it inevitably will be, by definition) and particularly the continuous gradation between 'undelayed' and 'delayed' monitoring.

A2.7 Detail criteria for 'Own Control Room/Cubicle'

The base criterion for the category 'Own Control Room/Cubicle' is:

With delayed monitoring (for 180 ms delay)	31	31
(add corrections from column 'A' below)	31	36
	48	5
Without delayed monitoring	15	15
(subject to the minimum value from column 'B' below)	15	18
	33	6

To these base values the following correction factors must be applied, depending on the studio type and the usage:

	A	B
Radio:		
Orchestral music	0 dB	20 dB
Drama	+ 6 dB	28 dB
Talks/continuity/narrators	+ 5 dB	25 dB
Continuity, 'pop'	+ 2 dB	20 dB
'Pop'	+ 9 dB	20 dB
Recital and small music	+10 dB	20 dB
Television:		
Large, general purpose	+10 dB	28 dB
News/interview	+ 5 dB	25 dB

In small studios the definitions of the above will be relatively clear. However, in large studios even without deliberately delayed monitoring there will be a significant delay due to propagation. Allowance may be made for different delay times by reducing the above base figures for delayed monitoring at a rate of 8 dB for 90 ms between the limits of 180 and 90 ms. For example, for a delay time of 135 ms, 4 dB can be subtracted.

A2.8 Outcome

When the calculated figures given above were presented to the representatives of the Radio, Television and World Service Directorates* there was a unanimous rejection on the grounds that they were 'obviously too low'. Thus it can be assumed that the condition 'e' in A2.1 above, which suggested that other factors may actually set the necessary criterion, is in fact the dominant constraint. Had it been necessary to continue the development of 'own-cubicle' criteria, this point would have needed further investigation. It is clear from the discrepancy between the criteria derived in this Appendix and those found by the RCP survey that this point would have been properly confirmed.

* The work predates the formation of Regional and News and Current Affairs Directorates.